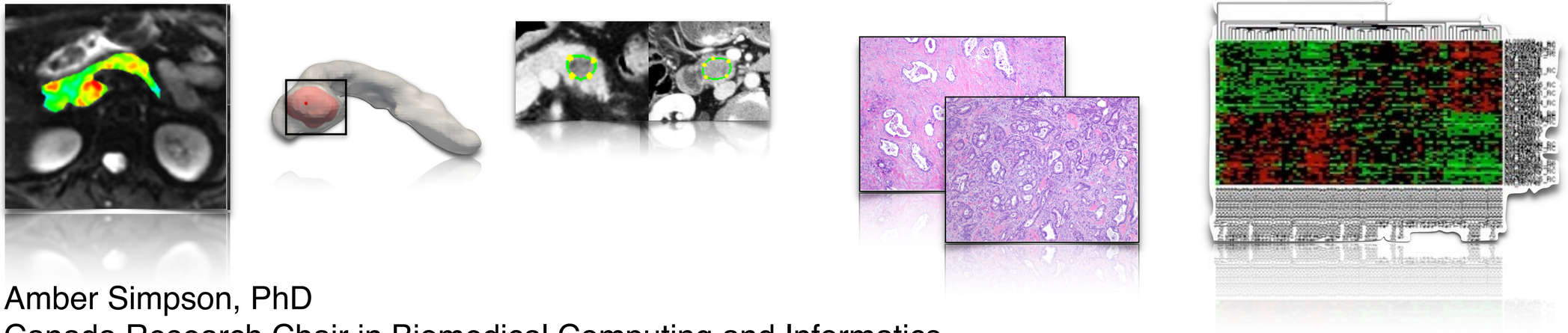
AI FOR RADIOLOGY



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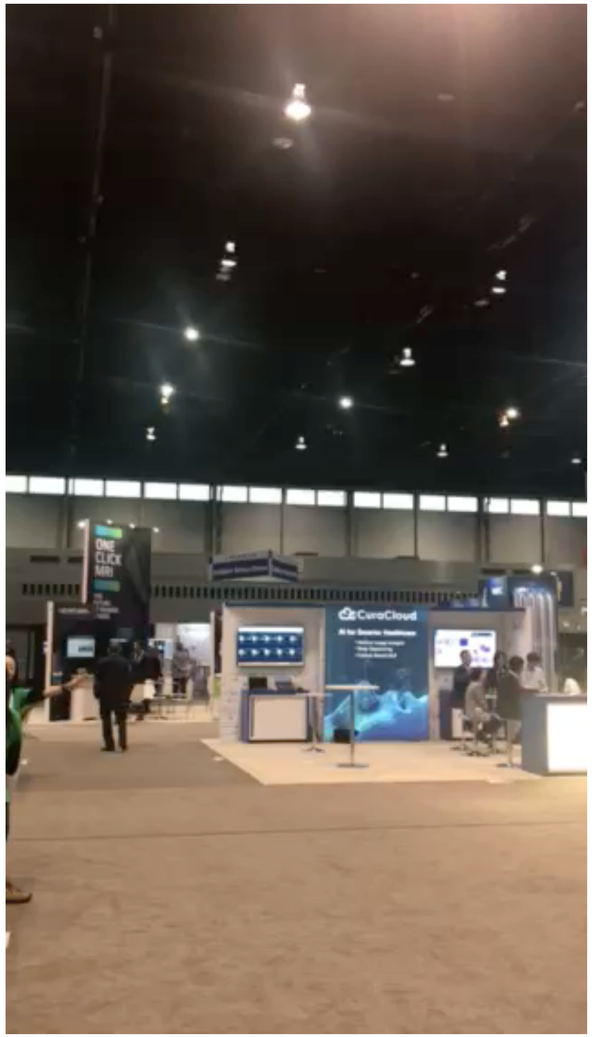
@profsimsim

Affiliate Member
Vector Institute for AI

AI Hype is Not Going Anywhere



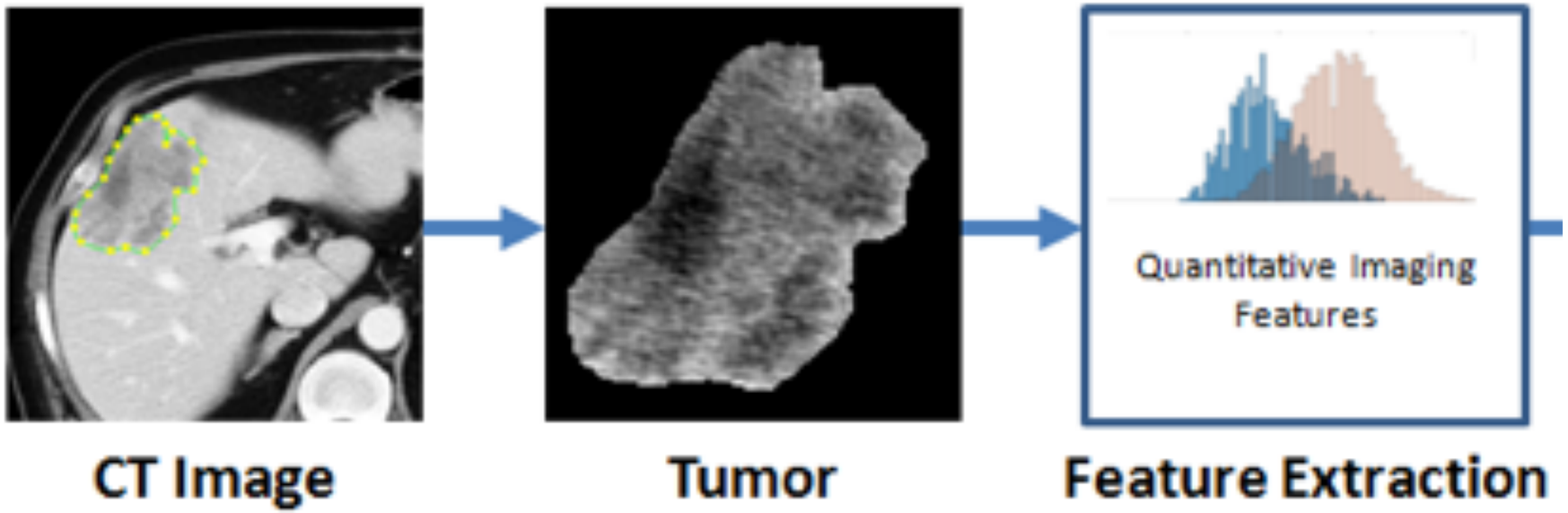
RSNA 2018

Hype has extended to politics …

Andrew Yang - Running for US President

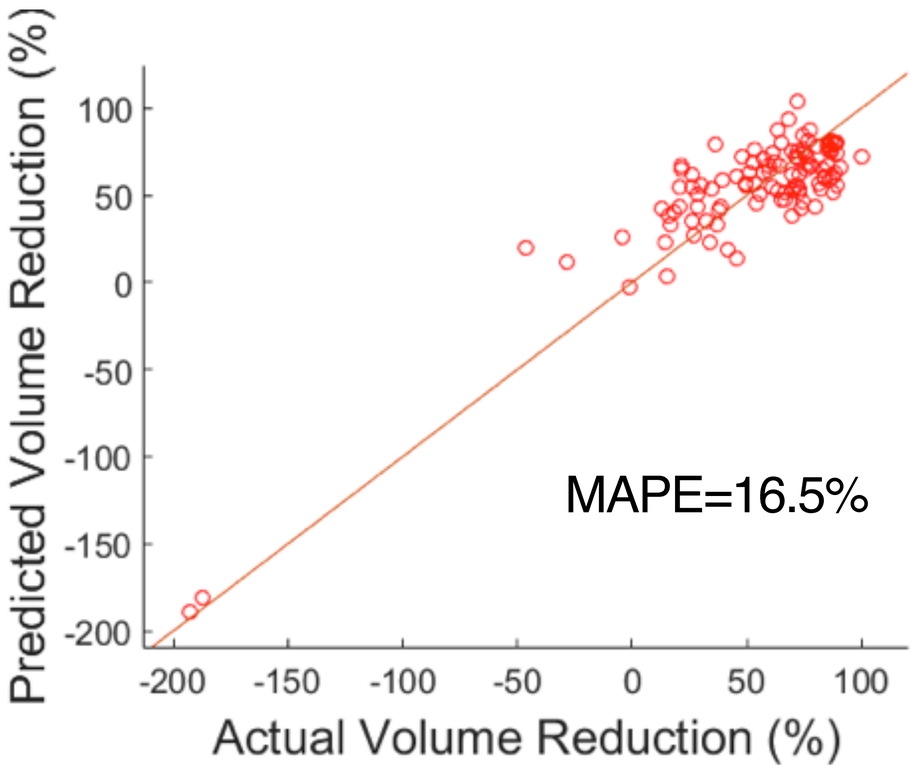
- Platform based on the Freedom Dividend: universal basic income of $1000/mo
- Offsets job loss due to automation
- He argues that “as AI becomes more advanced, 1/3 of workers will lose their jobs”

Example: AI to Predict Chemotherapy Response from CT Scans

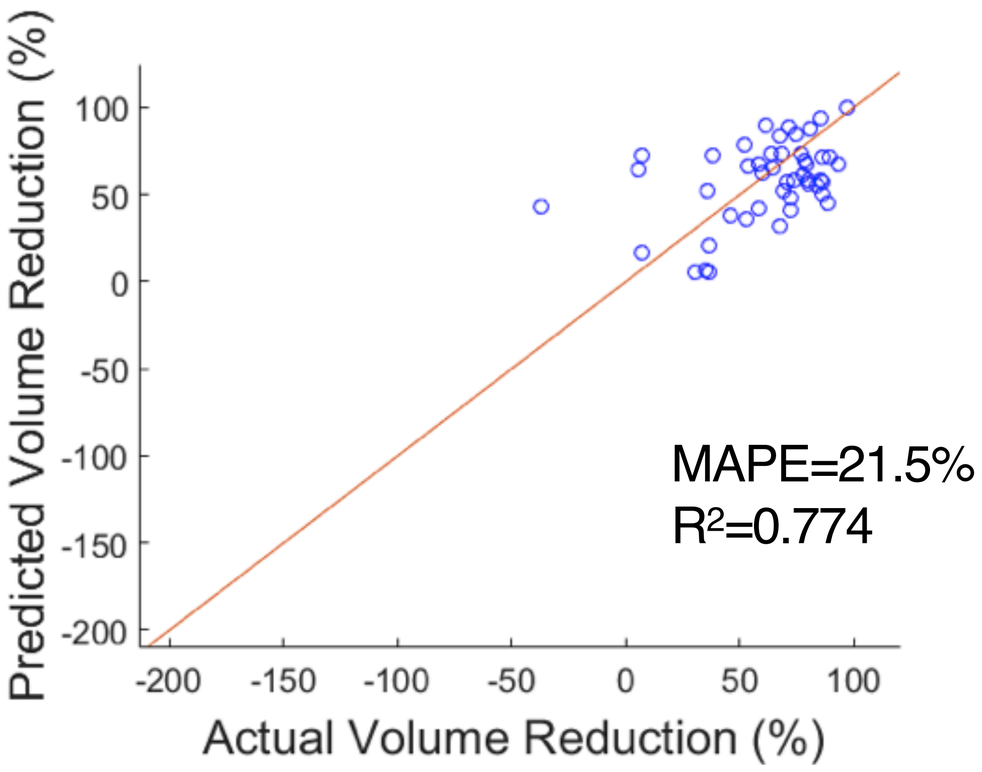


Creasy, J. M. et al. Quantitative imaging features of pretreatment CT predict volumetric response to chemotherapy in patients with colorectal liver metastases. Eur. Radiol. 1–10 (2018).

Results

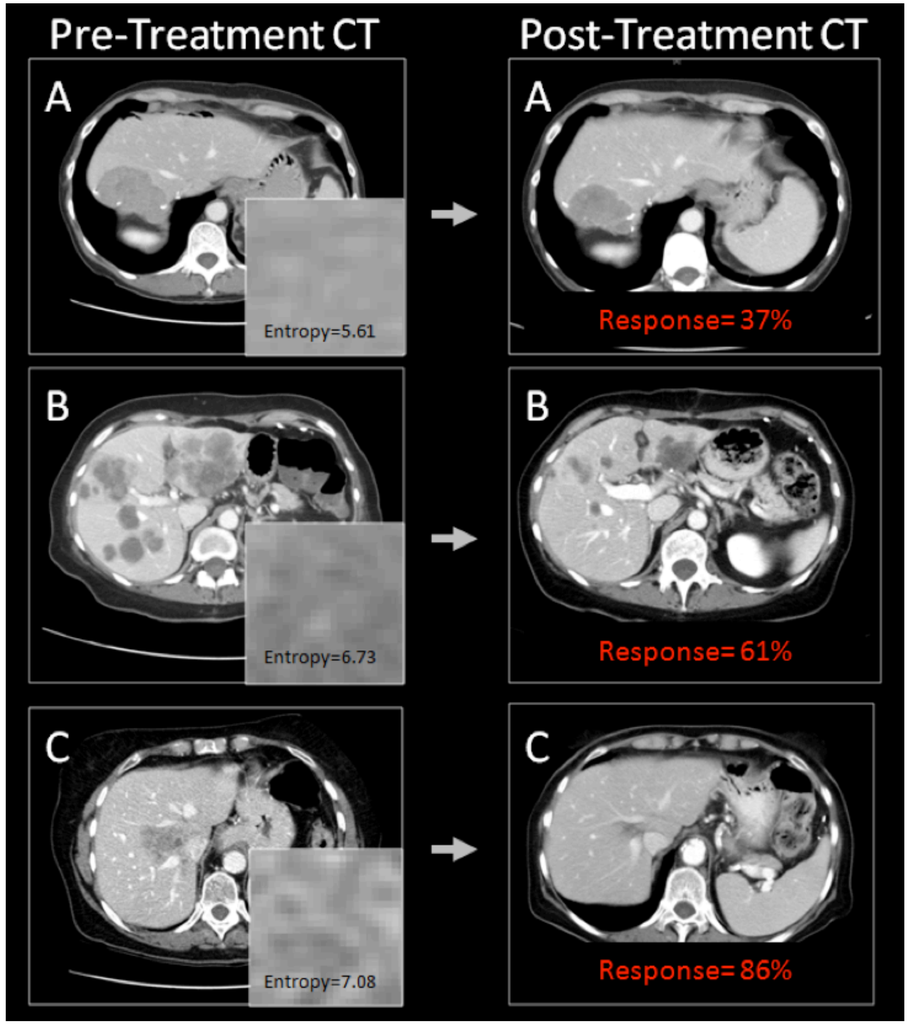


Training



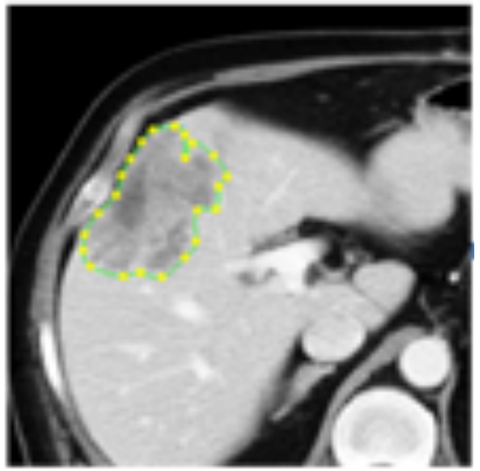
Testing

Higher Heterogeneity = Better Response



Exemplar Entropy Feature

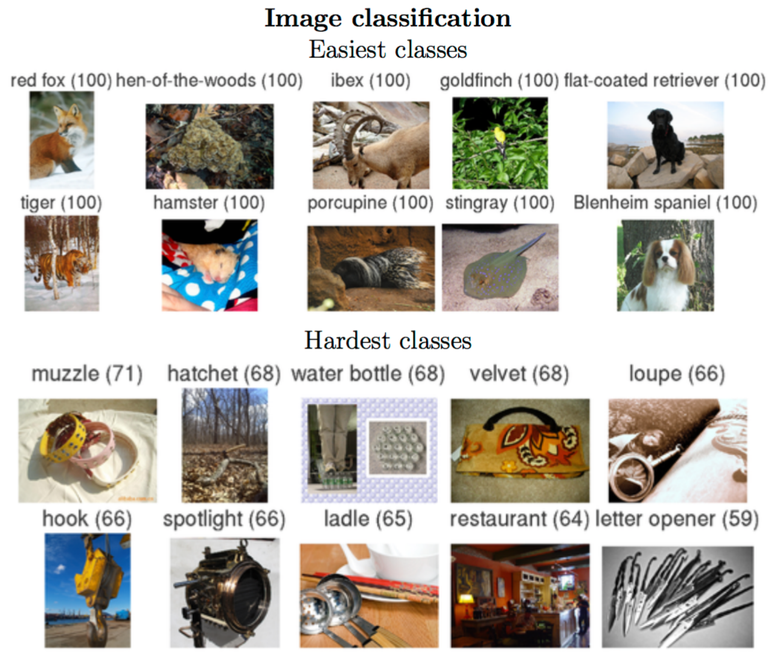
Image segmentation is a foundational problem in prediction/prognostication from images

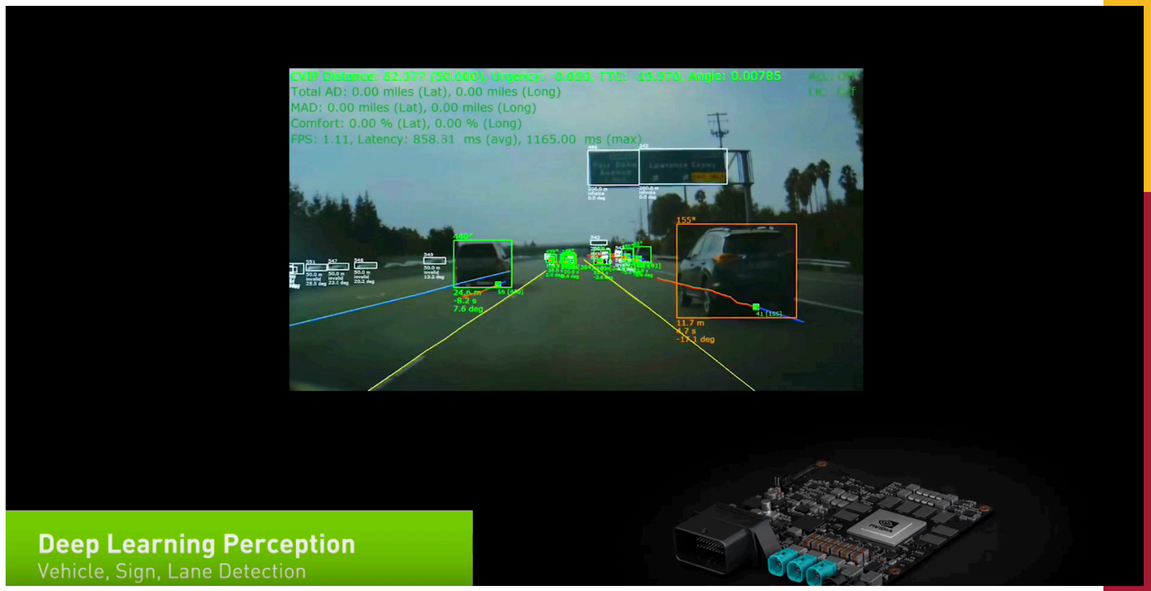


CT Image

Recall: Open Science Revolutionized Computer Vision

- Solved the object recognition problem
  - Visual Object Classes 2012 competition
  - Given an image, determine what is in the image (object recognition problem)
  - 10 million images with 1,000 labelled classes
  - Created ImageNet
  - Self-driving cars are now possible





NVIDIA DRIVE

MICCAI Medical Segmentation Decathlon

M. Jorge Cardoso

King's College London

Amber Simpson

Memorial Sloan Kettering Cancer Center

Olaf Ronneberger

Google Deepmind

Bjoern Menze

Technische Universität München

Bram van Ginneken

Radboud University Medical Center

Lena Maier-Hein

DKFZ German Cancer Research Center

Annette Kopp-Schneider

DKFZ German Cancer Research Center

Bennett Landman

Vanderbilt University

Geert Litjens

Radboud University Medical Center

Keyvan Farahani

National Institutes of Health

Ronald Summers

National Institutes of Health Clinical Center

Spyridon Bakas

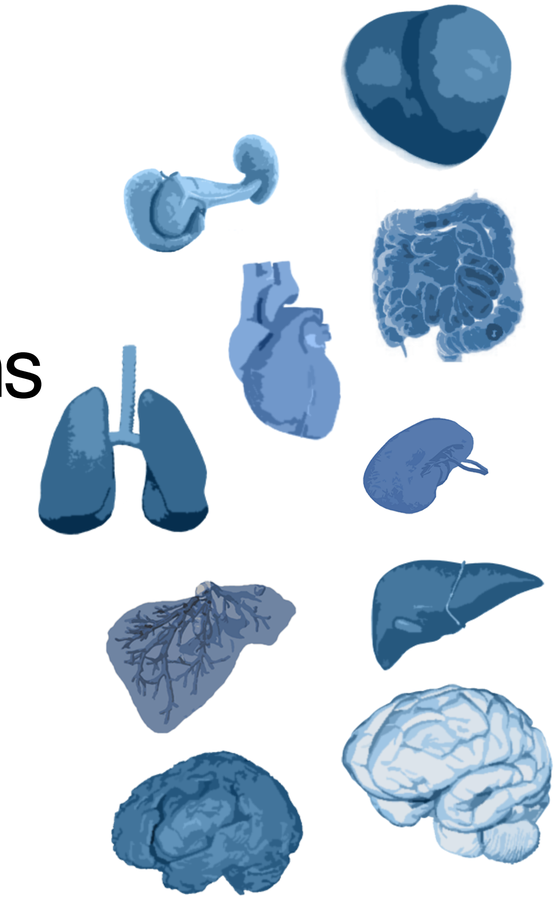
CBICA, University of Pennsylvania

Michela Antonelli

University College London

Medical Segmentation Decathlon Challenge

- Crowdsourcing challenge at MICCAI 2018
- Develop a semantic segmentation algorithm (or learning system) that can solve 10 segmentations tasks, separately without human interaction
- Toward an ImageNet for medical images
- http://medicaldecathlon.com/



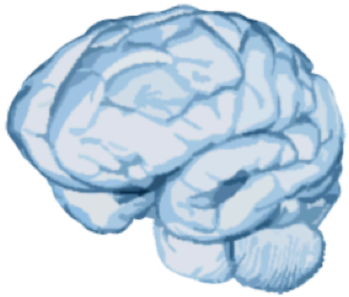
Ten tasks

The Data

All data = 2,634 CT scans
MSK = 1,114 CT scans

Liver Tumors

Brain Tumors



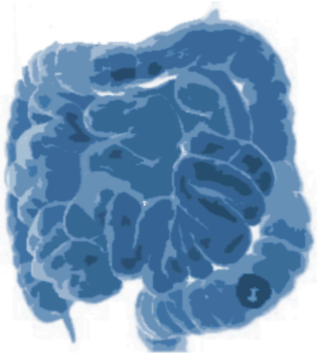
Hippocampus

Lung Tumors

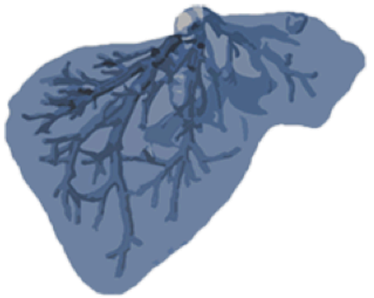
Prostate

Cardiac

Pancreas Tumor



Colon Tumor

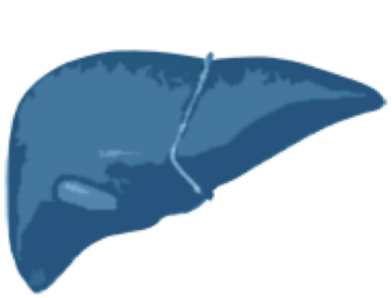


Hepatic Vessels

Spleen

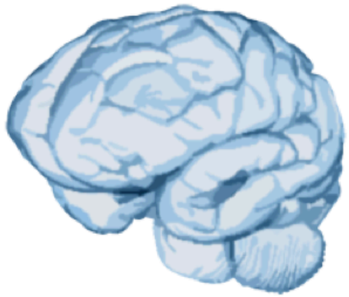
Data provided by my group at MSK

The Design



Liver Tumors

Brain Tumors



Hippocampus

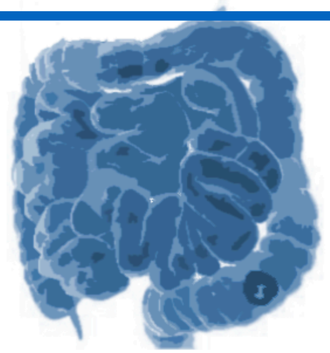
Lung Tumors

Prostate

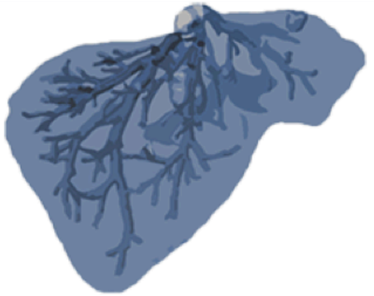
Cardiac

Pancreas Tumor

Phase 1



Colon Tumor

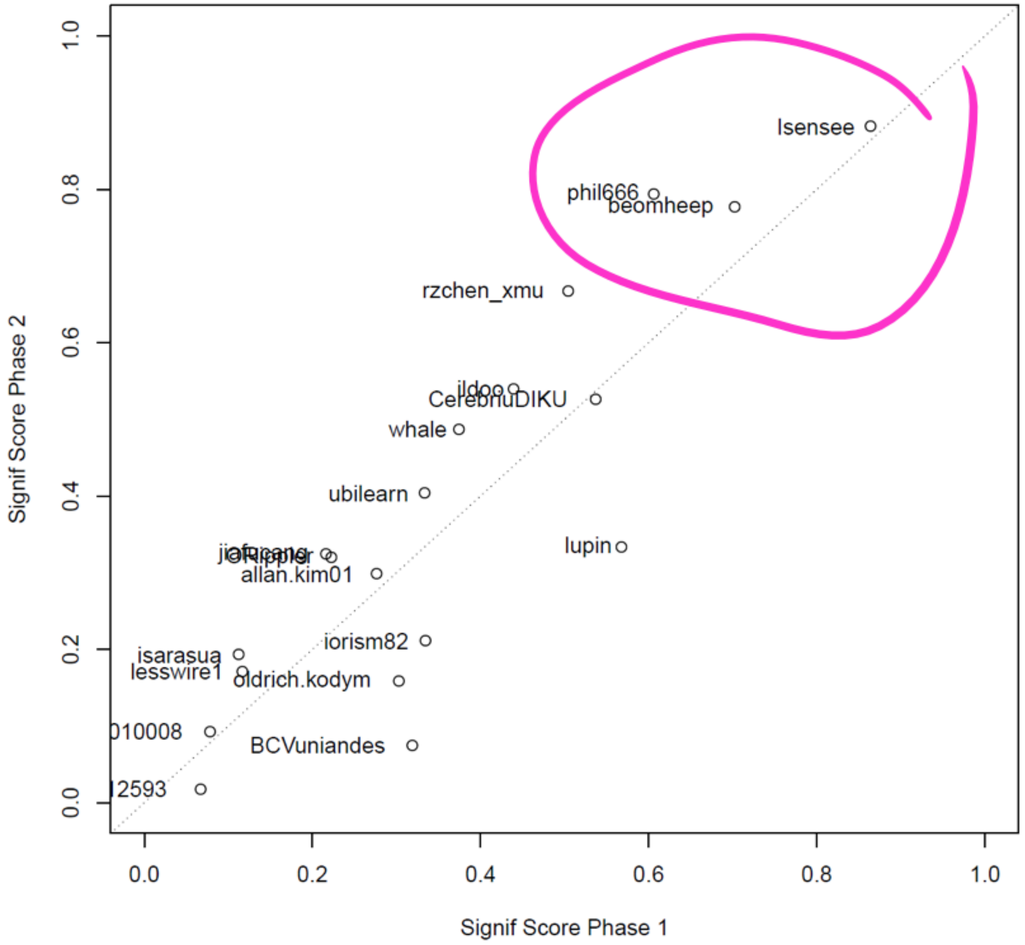


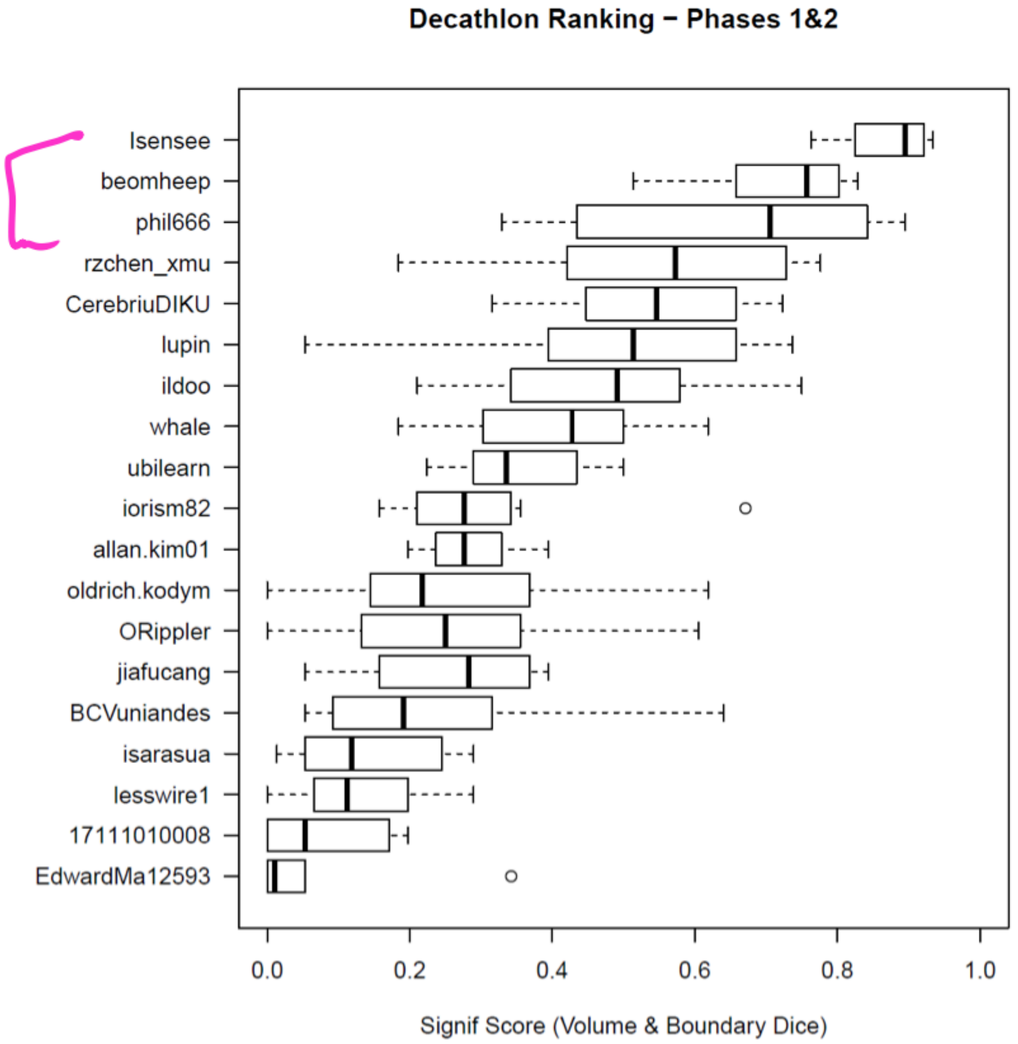
Hepatic Vessels

Spleen

Phase 2

Best Performance by Team





Best Performance by Task

Volume Dice

BRATS_1	"CerebriuDIKU"	"0.695"
BRATS_2	"Isensee"	"0.477"
BRATS_3	"Isensee"	"0.682"
la_1	"Isensee"	"0.928"
liver_1	"Isensee"	"0.952"
liver_2	"Isensee"	"0.737"
hippocamp._1	"Isensee"	"0.904"
hippocamp_2	"Isensee"	"0.889"
prostate_1	"Isensee"	"0.758"
prostate_2	"Isensee"	"0.896"
lung_1	"Isensee"	"0.692"
pancreas_1	"Isensee"	"0.795"
pancreas_2	"Isensee"	"0.523"
hepaticvessel_1	"Isensee"	"0.634"
hepaticvessel_2	"Isensee"	"0.694"
spleen_1	"beomheep"	"0.967"
colon_1	"Isensee"	"0.562"

Boundary Dice

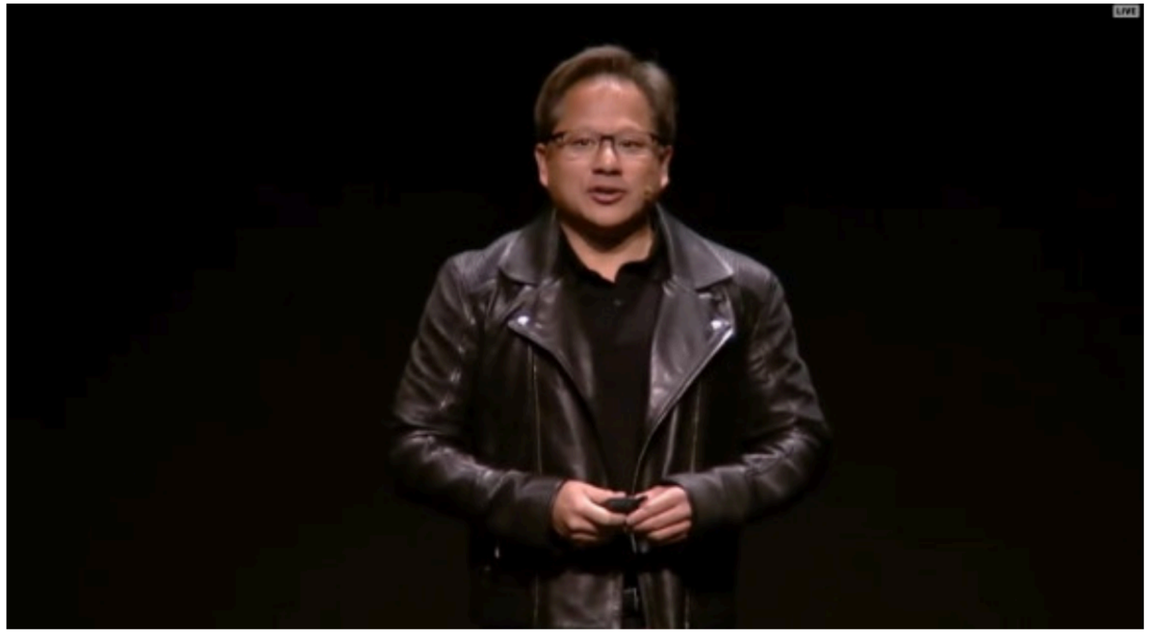
BRATS_1	"lupin"	"0.884"
BRATS_2	"Isensee"	"0.733"
BRATS_3	"Isensee"	"0.906"
la_1	"lupin"	"0.968"
liver_1	"lupin"	"0.983"
liver_2	"Isensee"	"0.884"
hippocamp._1	"Isensee"	"0.98"
hippocamp._2	"Isensee"	"0.979"
prostate_1	"Isensee"	"0.958"
prostate_2	"Isensee"	"0.989"
lung_1	"Isensee"	"0.691"
pancreas_1	"Isensee"	"0.954"
pancreas_2	"Isensee"	"0.728"
hepaticvessel_1	"Isensee"	"0.834"
hepaticvessel_2	"Isensee"	"0.788"
spleen_1	"phil666"	"0.997"
colon_1	"Isensee"	"0.678"

Prized by Nvidia

Data Availability

Nvidia’s Clara health care platform and medical imaging SDKs hit general availability

KYLE WIGGERS @KYLE_L_WIGGERS NOVEMBER 26, 2018 6:00 AM



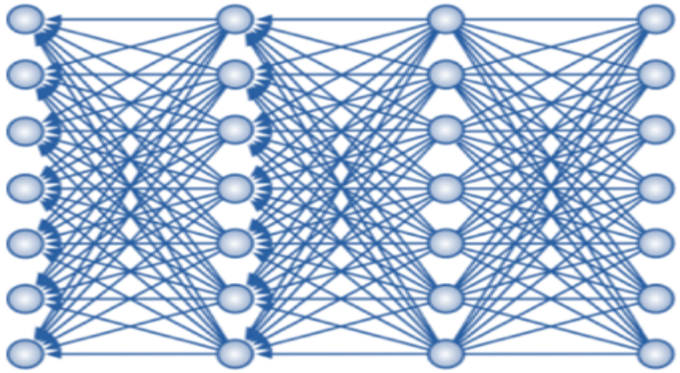
Above: Jensen Huang, CEO of Nvidia.

Image Credit: Nvidia

In the initial release, Nvidia is making available an AI system that won the University of Pennsylvania Perelman School of Medicine’s BrATS challenge for 3D MRI brain tumor segmentation at the 2018 International Conference On Medical Image Computing and Computer Assisted Intervention. Among the other AI models shipping are a tumor segmentation model trained on magnetic resonance imaging data, and 3D pancreas and tumor segmentation on portal venous phase CT data.

The Vision at Queen's

>5,000 segmented MSK scans



Semantic Segmentation Network

Canadian Cancer Trials Group
Groupe canadien des essais sur le cancer

Kingston Health Sciences Centre
Centre des sciences de la santé de Kingston

F. Raney
MSc Student - CS

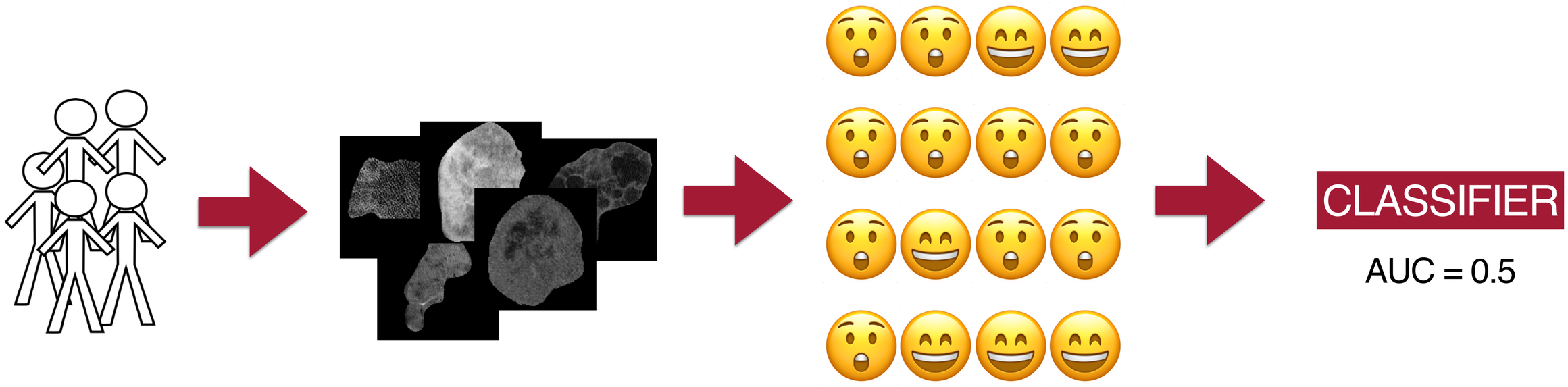
Penn
University of Pennsylvania

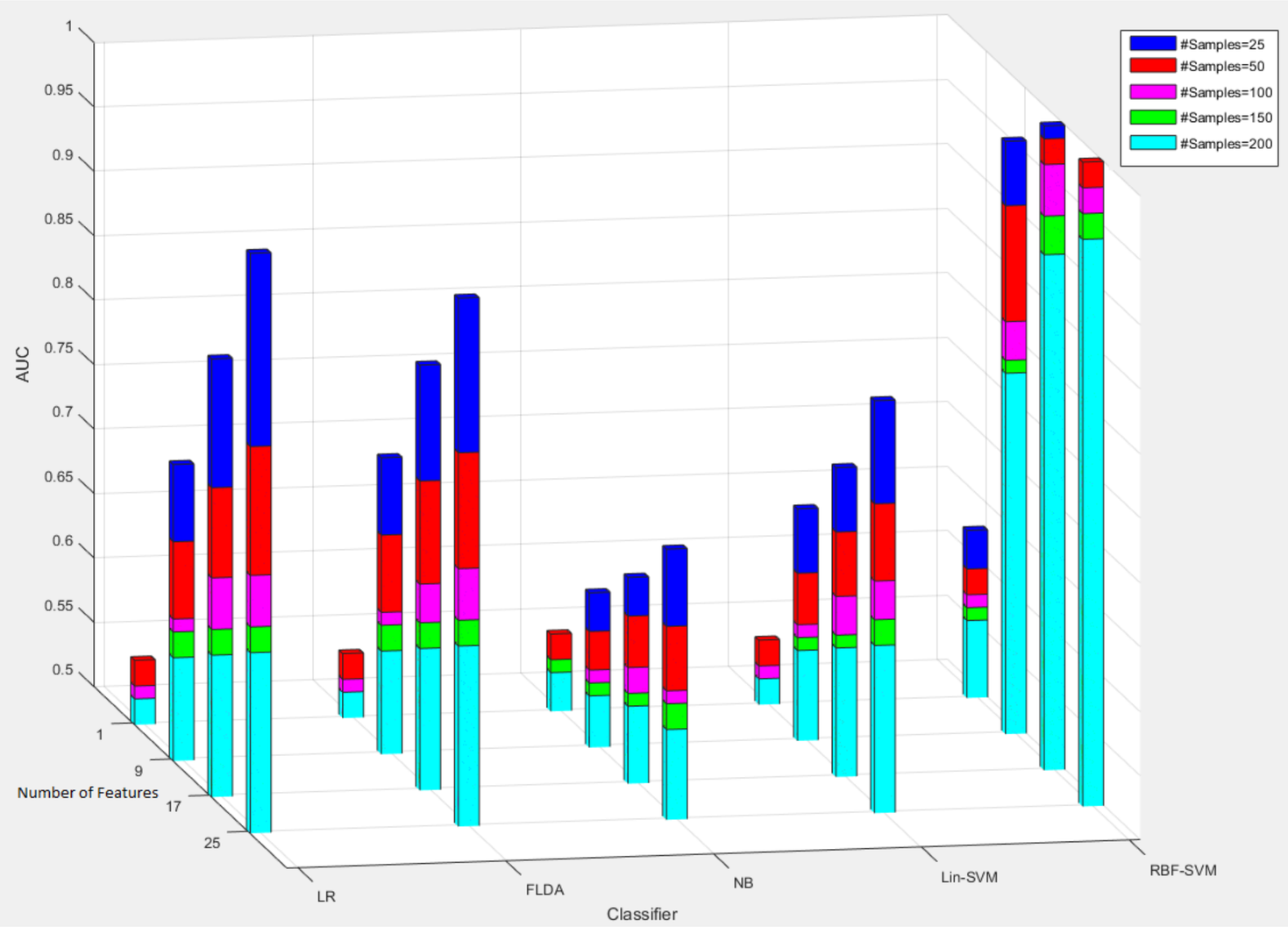
Federated Networks

Sharing data may not solve everything but hoarding data has solved nothing

AI can predict any outcome from any data

Data Overfitting in Imaging Biomarkers





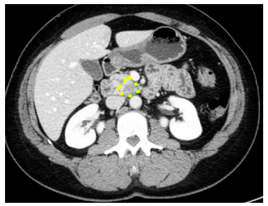
Radiomics Can Predict Anything

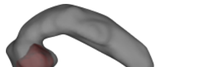
Health Data Silos

Radiology-Specific Challenges

- protected health information is notoriously hard to remove from images (e.g. NIH name badges example)
- lack of interoperability in imaging data
- lack of image acquisition standardization
- lack of standardized pipelines for sharing and anonymizing imaging data
- huge fines for leaking PHI (e.g. Columbia experience)

Toward Clinical Trial Use





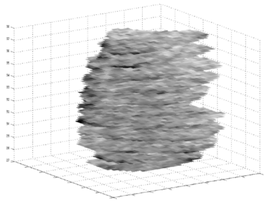
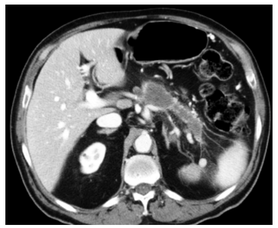
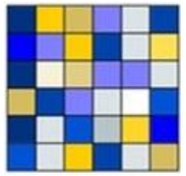
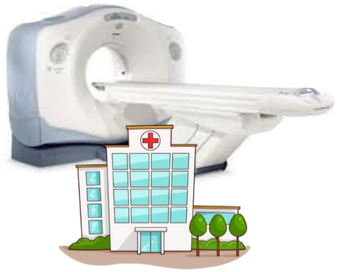


Image Segmentation

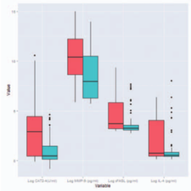




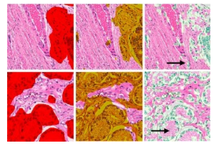
Software for Pulling Data at Scale



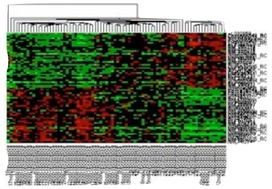
Reproducibility/ Repeatability



Protein Markers

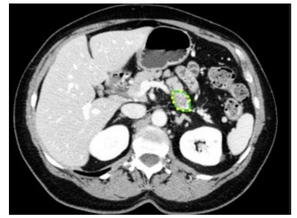


Pathology



Genomics

Biological Rationale



Data Federation

Trainees

Research Staff

Surgeons

Pathologists

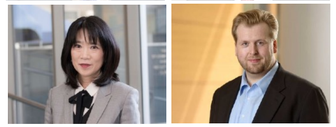
Medical Oncologists

Radiologists

Biostatistics/Informatics

Scientists

Digital Pathology



Medical Physics

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